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THE MOST IMPORTANT MOTOR COORDINATION SKILLS IN THE GOALKEEPERS' TRAINING

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Abstract

The conducted studies were aimed at identifying the most important coordination motor skills (CMS) among junior footballers playing as the goalkeepers as well as defining the impact of physical activity on young players' CMS. In this study there were used seven tests, which were able to assess in comprehensive and objective way seven most important CMS of football players.

The studies were conducted with the participation of 26 goalkeepers from the Polish leagues of the first, second and third league, who played in junior teams in the 2015/2016 season. Statistica 10.1 PL program was used in statistical calculations as well as discriminative function analysis and one-way analysis of variance (ANOVA). The dominant CMS in young footballers playing as goalkeepers were: spatial orientation, coupled motion, adaptation and displacement of movement actions as well as, to a lesser extent, kinesthetic differentiation of movements. The highest level of CMS the goalkeepers achieved in the main part of training in the situation of the highest training load. It should be continued to monitor the level of CMS of goalkeepers, taking into account the type of exercise that focuses on developing particular motor skills.

Key words: coordination of motor skills, football, goalkeepers.

Анджей Сорока. Найважливіші навички рухової координації під час підготовки голкіперів. Проведені дослідження спрямовано на виявлення найважливіших координаційних рухових навичок (КРН) футболістів-юніорів, які є голкіперами, а також визначення впливу фізичної активності CMS футболістів-юніорів. Застосовано сім тестів, за допомогою яких об'єктивно оцінено сім найважливіших КРН футболістів-юніорів.

Дослідження проводили за участю 26 голкіперів збірних Польщі першої, другої та третьої ліг, які грали в командах-юніорів у сезоні 2015/2016 рр. Застосовано статистику 10.1 програми PL для статистичних розрахунків, а також для аналізу дискримінаційних функцій та одностороннього аналізу дисперсії (ANOVA). Домінуючими КРН футболістів-юніорів, виступаючих у ролі голкіперів, були просторова орієнтація, спарений рух, адаптація та зміщення дій під час руху, а також меншою мірою кінестетична диференціація рухів. Найвищий рівень КРН у голкіперів досягається в основній частині тренувань у ситуації з найвищим тренувальним навантаженням. Потрібно продовжувати стежити за рівнем КРН у голкіперів, ураховуючи ті види фізичних вправ, що зосереджені на розвитку певних рухових навичок.

Ключові слова: координація рухових навичок, футбол, воротарі.

Анджей Сорока. Важнейшие навыки двигательной координации при подготовке голкиперов. Проведенные исследования направлены на выявление важнейших координационных двигательных навыков (КДН) футболистов-юниоров, которые являются голкиперами, а также определение влияния физической активности КДН футболистов-юниоров. В этом исследовании применено семь тестов, с помощью которых объективно оценены семь важнейших КДН футболистов-юниоров.

Исследования проводили с участием 26 голкиперов сборных Польши первой, второй и третьей лиг, которые играли в командах-юниоров в сезоне 2015/2016 гг. Примененная статистика 10.1 программы PL для статистических расчетов, а также для анализа дискриминационных функций и одностороннего анализа дисперсии (ANOVA). Доминирующими КДН футболистов-юниоров, выступающих в роли голкиперов, были пространственная ориентация, спаренное движение, адаптация и смещение действий во время движения, а также, в меньшей степени, кинестетическая дифференциация движений. Самый высокий уровень КДН в голкиперов достигается в основной части тренировок в ситуации с высоким тренировочным нагрузкам. Нужно продолжать следить за уровнем КДН в голкиперов, учитывая виды физических упражнений, которые сосредоточены на развитии определенных двигательных навыков.

Ключевые слова: координация двигательных навыков, футбол, вратари.

Introduction. Identification of young football talents has always aroused and still arouses great interest of people associated with this sport discipline. The primary goal of monitoring the development of young football players is to predict future results and forecast development processes aimed at achieving success in adult competition (Reilly and others 2000).

In order to distinguish talented players, in addition to observation and analysis of technical and tactical skills that are very essential in football, there are also studied anthropometric, physical and motor features, including CMS (Buchheit et al. 2012).

Long-term forecasting of future sport results of young players is a complicated task due to the need to use multivariate indicators (Carling et al. 2009). It is believed that at the stage of the forecast of development, special attention should be paid to the physical activity of future players at the age of 6–12. Players who perform different physical activities at a later stage of development need less time for specialized training, which directly affects the high sport level (Baker et al. 2003). A comprehensive training, rather than early specialization, has an influence on the development of motor skills that embrace perceptual and physical factors (Cote et al. 2009), including general motor coordination so important in football, spatial orientation, body balance and other control mechanisms of body posture (Bobbio and others 2009).

There are numerous studies verifying football skills, which provide evidence that the world's elite football players are characterized by excellent physical and motor skills (Reilly, 2003), technical ones (Bradley et al. 2013) as well as unique features of perception, which is directly related to making fast and accurate decisions (Roca et al. 2013; Sarmiento et al. 2014; Furley and Memmert 2015). It has been shown that high physical and motor activity of players even to a higher degree increases their ability to predict and react to various situations during the game, including those difficult ones (Bishop et al. 2013; Wallace and Norton 2014).

It has become common to publish characteristics of professional players (Barros et al. 2007; Bloomfield et al. 2007; Bradley et al. 2009; Dellal et al. 2011; Di Salvo et al. 2007; Rampinini et al. 2007; Wong et al. 2008), whereas studies assessing different characteristics of young players are significantly limited, showing deficiencies in systematic recording, what affects the proper tracking of player's development (Gil et al. 2007; Le Gall et al. 2010; Malina et al. 2004).

Therefore, it is becoming more and more important to conduct studies, which aim at analyzing various parameters related to the development of young players at different stages of their careers. These studies would help to identify and, consequently, help in model development.

The aim of this work was to identify seven most important CMS among junior footballers, playing on the position of goalkeeper. The purpose of these studies was also to determine the impact of physical effort, applied to young players in the form of specialized aerobic training of high intensity, on their CMS.

Material and Methods. In this work there was used a battery of tests developed by Ljach and Witkowski (2004), which provide a comprehensive and objective assessment of seven most important CMS of football players. Out of 23 most reliable tests and indicators for assessing the leading CMS in football, for the purpose of this study there were used one test for each of seven coordination skills: 1. Test that assesses the ability to sense the rhythm of movement which consists in rolling the ball on time with a leading foot. 2. Test assessing the ability to maintain the balance, which consists of standing on one foot with keeping the ball on the other leg. 3. Test assessing the ability to kinetic differentiation of movements, consisting in hitting the ball to the goal. 4. Test assesses the ability to adjust and switch movement activities, involving running with circling the poles while running the ball. 5. Test assessing the ability to combine (coupling) the movements, which is a slalom between the poles with running two balls at the same time. 6. Test assessing the ability of fast reaction that consists on stopping the rolling ball with the foot. 7. Test to assess the ability of spatial orientation, which consists in running to numbered balls.

There were examined 26 footballers, playing on the position of goalkeepers in the first, second and third league. The studies were conducted in the 2015/2016 season. The average age of examined players was $17,21 \pm 3,21$ years old, the body height was $183,22 \pm 4,20$, the body weight $72,54 \pm 3,34$, and professional internship with specialization in goalkeeper position $5,28 \pm 2,76$.

There were conducted three test samples. Before the first test sample, goalkeepers were subjected to a short warm-up, which consisted of a short low-intensity run, gymnastic exercises and stretching exercises. The warm-up aimed at preparing players to test samples as well as preventing injuries. The goalkeepers made their first test after the warm-up and short (up to 5 minutes) rest time. The second test was conducted after 60 minutes of intensive training, which consisted of defending shots to the goal with a fall and without it in series of 10 shots with intervals between series that did not allow for full rest. The third sample test took place after another 20 minutes of oxygen training and 10 minutes of regenerative training with elements of stretching exercises.

Statistica 10.1 PL was used for statistical analysis and discriminant function analysis. There was applied a classification function in the form of calculation of coefficients that were defined for each formed group.

Prior to conduct analysis, there was examined multivariate normality by checking each variable for normal distribution. It was assumed that the matrixes of variables' variances were homogeneous in groups. Prior to the use of one-way analysis of variance (ANOVA), the normality of distribution of variables and homogeneity of variances were checked. There was used a test from the Post – hoc group of Tukey's HSD (Honestly Significant Difference) tests. It was applied in order to check between which averages appeared significant differences. Statistically significant were differences of averages, of which probability of randomness was less than 0,05.

Study Results. In the created model there were found four of seven proposed to the analysis tests determining particular coordination skills: spatial orientation, movement coupling, adaptation and displacement of movement activities and kinesthetic differentiation of movements. Beyond the model there were tests that assessed coordination skills such as sense of rhythm of movement, dynamic and static balance as well as speed of reaction by trying to stop the rolling ball with the foot.

The created model showed high discriminatory value, what proves the validity and legitimacy of using these tests that assess coordination skills for goalkeepers. Wilks's Lambda value for this model amounted to 0,201, whereas in the case of particular coordination skills tested, it did not exceed 0,300.

The created model of discriminative function indicated that the most important coordination skill among examined goalkeepers was spatial orientation. The test consisted of running to numbered balls, where what counted was the time of running the test with maintaining the rules set. The value of classification function was significantly the highest at $p = 0,005$ in the case of a third test sample completed after the entire goalkeepers' training, compared to the previous test samples, which amounted to respectively 191,35 for the first test and 187,19 for the second test. The results of table 2 indicate that the shortest time (10,46 sec) of covered distance, at $p < 0,001$, was achieved in the case of the second test sample performed after the main part of the specialized training of goalkeepers, while in the first test sample it was 10,91 sec. and 10,94 sec. in the third test sample.

Also the high values of classification function were demonstrated in the case of coordination skills such as combining movements. The test consisted of a slalom between the poles with running two balls at the same time. There was assessed the time, specified in the test, that was necessary to cover the distance with subject to its correctness. Similarly to the previous examined coordination skill, also while determining the importance of combining movements, the highest significant value, at $p = 0,022$, was obtained in the case of the third test sample (127,85), as compared to the first test sample (134,09) and the third one (136,35). This was also reflected in the average time needed to cover particular test samples, where significantly the shortest time was achieved by players in the second sample (5,16 sec) at $p = 0,008$, while in the first sample it was 5,49 sec and in the third 5,76 sec.

The third most important in terms of classification function were coordination skills related to the assessment of the ability to adapt and displace movement actions, involving circling the poles while running the ball with the foot. In the case of this test, there were no significant differences in the size of classification function between individual samples, although the mean lengths of time were significantly higher in the case of the second sample (9,62 sec) and the first one (9,67 sec) at $p = 0,015$, in relation to the third sample (10,28 sec).

In the model there were also found coordination skills such as kinesthetic differentiation of movements (ball feeling) that were assessed by hitting the ball to the goal, and the result was the sum of points obtained from 10 ball hits with the leading foot. The players obtained significantly higher values of classification function at $p = 0,014$ in the second test sample (3,98) and the first one (3,59), comparing to the third test 1,71. There were also significant differences in the average point value, at $p < 0,001$, which the players performed in the first (4,46) and the second (4,39) test sample, comparing to the third one (2,18).

Summary. The conducted studies allowed to identify the most important CMS among junior footballers who play on the position of the goalkeeper. It was shown that out of seven leading CMS, spatial orientation appeared to be the most important. It seems that this test is most closely related to behaviors of goalkeepers on the field, during the match and training. In this test, the shortest execution time has occurred in the second test sample, which may indicate that displaying these coordination skills to the highest extent appear immediately after physical effort of high intensity that is in the culmination phase of training. The importance of this CMS is related to the behavior of the player on the pitch as during the game there are required, especially in the case of goalkeepers, outstanding abilities of spatial orientation. These are related to tracking the ball during the game, while moving and changing position of players of the own and opposite teams as well as to the speed of perception of dynamically changing situations on the pitch and the position of player's body in moments of goalkeeper's interventions.

Table 1

Tests for the Leading Coordination Skills of Football Players

Tests Assessing the Leading Coordination Skills	Wilks' Lambda Discriminant Function Model: 0,201; F=5,718; p<0,001			Classification Function		
	Wilks' Lambda	F Value	P Value	Order of Conducted Tests		
				I Sample p=0,333	II Sample p=0,333	III Sample p=0,333
Kinesthetic differentiation of movements (feeling the ball)	0,273	4,952	0,014*	3,59	3,98	1,71
Spatial orientation	0,295	6,516	0,005*	191,35	187,19	197,45
Combining (coupling) movements	0,265	4,343	0,022*	134,09	127,85	136,35
Adaptation and displacement of movement activities	0,225	1,639	1,639	22,30	22,30	24,57
Constant				1332,6	1285,6	1422,9

*– level of significant difference at $p < 0.050$

Table 2

Average Values of Selected Tests Performed in three Consecutive Tests

Tests Assessing the Leading Coordination Skills	F	p	Order of Conducted Tests		
			I (X)	II (X)	III (X)
Kinesthetic Differentiation of Movements (Feeling the Ball)	16,727	0,001*	4,46	4,39	2,18
Spatial Orientation	10,221	0,001*	10,91	10,46	10,94
Combining (Coupling) Movements	5,533	0,008*	5,49	5,16	5,76
Adaptation and Displacement of Movement activities displacement of movement activities ch	4,712	0,015*	9,67	9,62	10,28

*– level of significant difference at $p < 0,050$.

The assessment of combining movements examined using a test consisted of a slalom between the poles with running two balls at the same time is one of the most difficult from the proposed battery of 23 tests. It requires lots of physical and emotional involvement as well as outstanding skills of perception and orientation in space. Coupling of movements appear mostly in the case of goalkeepers due to their ability to use the upper and lower limbs and in the game there are often used other parts of the body.

Additionally, as in the spatial orientation test, also while examining the combining of movements the second sample achieved the shortest time in the test, what can be interpreted as a disclosure of skills at the moment of the highest load of the player during the game. The third sample that is at the end of the training, conducted these two tests at the longest time, which is equivalent to the lowest exposure of examined CMS.

A test that assesses the adaptation and displacement of movement actions, that has proved to be important in conducted studies, also belongs to quite complex in the sense of execution. It is another proof that in the case of goalkeepers very important are the abilities related to movement, with complicated and physically demanding interventions, involving many parts of the body as well as senses related to vision, sense of space and precision of movement. Also in the case of this test, the lowest values occurred just after the training, when players were tired due to conducted training classes. This may indicate that the goalkeeper achieves the highest level of coordination skill in the culmination phase of training, that is at the moment of the highest physical activity. After such physical effort, longer rest does not have a positive influence on coordination behaviors, especially on those with complicated structure.

The results of the study on one hand pointed to the importance of particular CMS of young goalkeepers' training, but also forced to consider whether obtained results did not come from the specificity of goalkeeper's training, aimed at developing those abilities that were exposed in the studies. This is the reason why there is a need for further studies that will include the orientation and quality of goalkeepers' training. It would be reasonable to compare the results of conducted tests with the results of tests conducted on players from other positions on the pitch.

Conclusions

1. In the case of goalkeepers the dominant CMS were: spatial orientation, movement coupling, adaptation and displacement of movement activities and kinesthetic differentiation of movements.
2. The goalkeepers achieved the highest level of CMS in the main part of training in the situation of the highest training load. After the end of training, the level of coordination skills decreased significantly and there were even lower than those achieved by players immediately after the warm up prior to training.
3. There should be systematic monitoring of the level of goalkeepers' CMS, also including the type of performed exercises that aim at developing individual CMS.

Application Conclusions

1. The exercises that enhance coordination skills of goalkeepers should be performed in the culmination stage of training, in the situation of the highest motor activity of the players.
2. In the training focused on CMS there should be paid particular attention to exercises that develop spatial orientation, movement coupling, adaptation and displacement of movement activities and kinesthetic differentiation of movements.

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